A Comparison of the SWAN and WAM Wave Models for Nearshore Wave Predictions

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Goal of the study

- Compare two third generation wave modeling codes
- WAM developed for deep water
  - nearshore capabilities added
- SWAN developed for nearshore
- Which predicts nearshore wave conditions more accurately?

Basic physics in WAM and SWAN

- Wave propagation in time and space
- Wave generation by wind
- Shoaling and refraction due to current and depth
- White capping and bottom friction
- Quadruplet wave-wave interaction

Formulations Specific to SWAN

- Depth-induced wave breaking
- Triad wave-wave interactions
- SWAN propagates only on a Cartesian mesh
- WAM propagates on spherical or Cartesian mesh

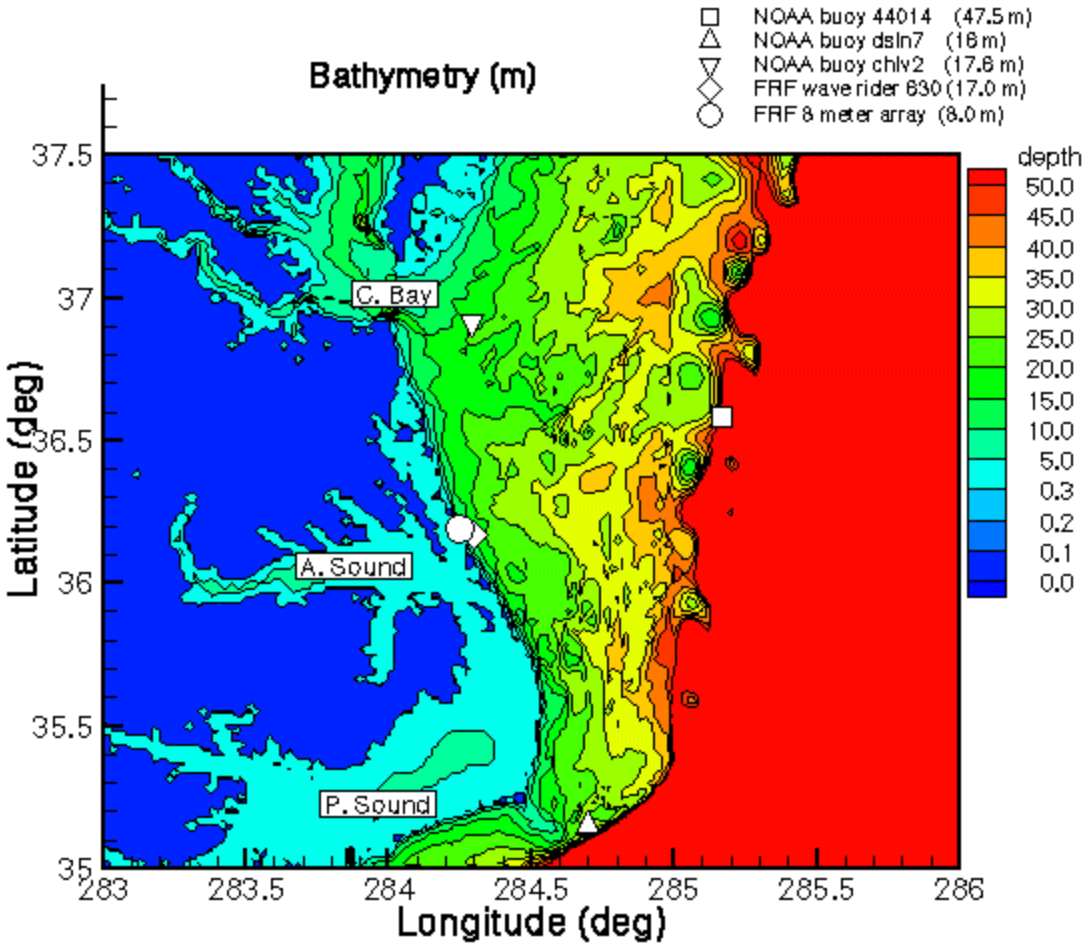
WAM and SWAN solvers

- WAM solves a wave action transport equation
- SWAN solves a spectral action balance equation
- frequency and directional and propagation space
- WAM uses explicit scheme in propagation space
- SWAN uses implicit scheme in propagation space
- 25 frequencies and 25 directions used

Test case: Hindcast of Hurricane 1995 Luis

- Cardone wind fields used
- White curve is the eye of the hurricane starting 08/29/95
- Wind speed contours
- Significant wave height, mean wave direction, peak period
- Evaluation parameters
  - rms differences between the computations and measurements
  - bias between computations and measurements

Bathymetry and location of test sites



Test sites

Test site	Latitude	longitude	Water depth
44014	36.58 N	-74.83 W	47.5 m
dsln7	35.15 N	-75.30 W	16.0 m
chlv2	36.91 N	-75.71 W	17.6 m
FRF wr630	36.17 N	-75.70 W	17.0 m
FRF 8 m	36.1902 N	-75.74533 W	8 m

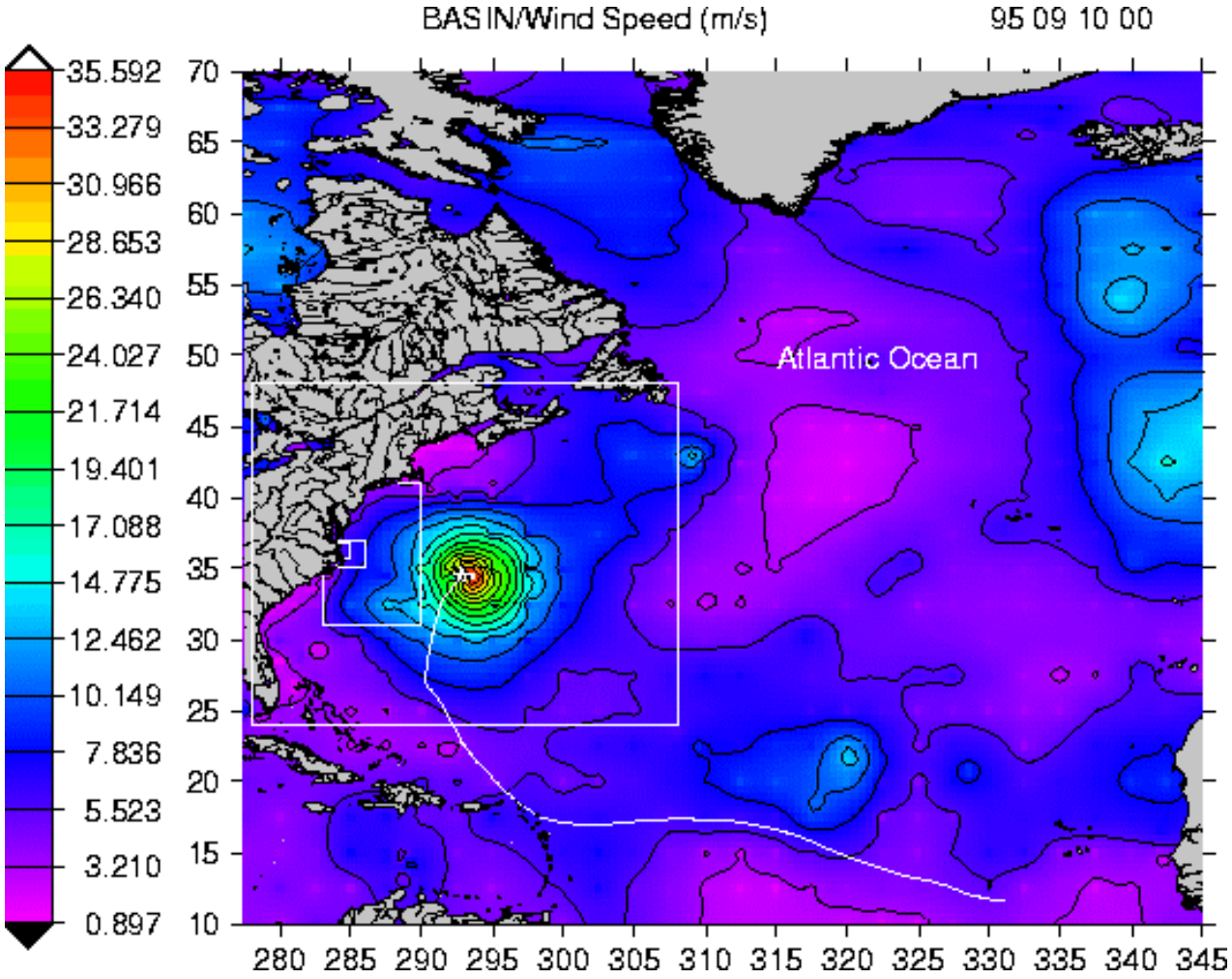
WAM nests

Zone	*Cells*	*Resolution*	*Lo-mesh size*	*La-mesh size*
Basin	135x120	30’	54.7	55.5
Region	120x96	15’	25.4	27.8
SUB1	84x120	5’	7.9	9.3
SUB2	96x96	5/4’	1.9	2.3

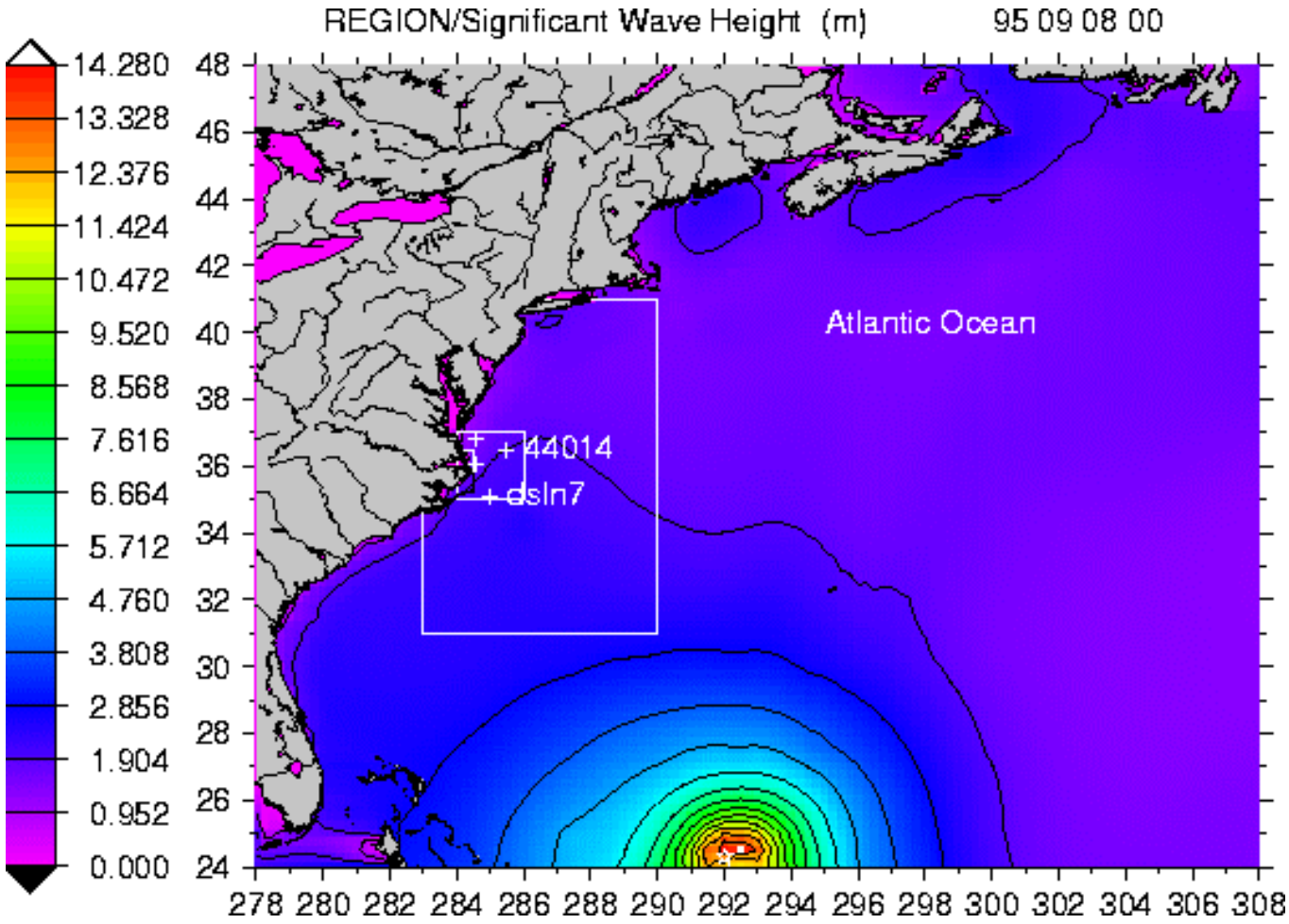
SWAN nests

Zone	*Cells*	*Resolution*	*Lo-mesh size*	*La-mesh size*
SUB2	96x96	5/4’	1.90 km	2.31 km
SUB3	60x90	½’	0.75 km	0.93 km
SUB4	41x84	1/10’	0.150 km	0.19 km

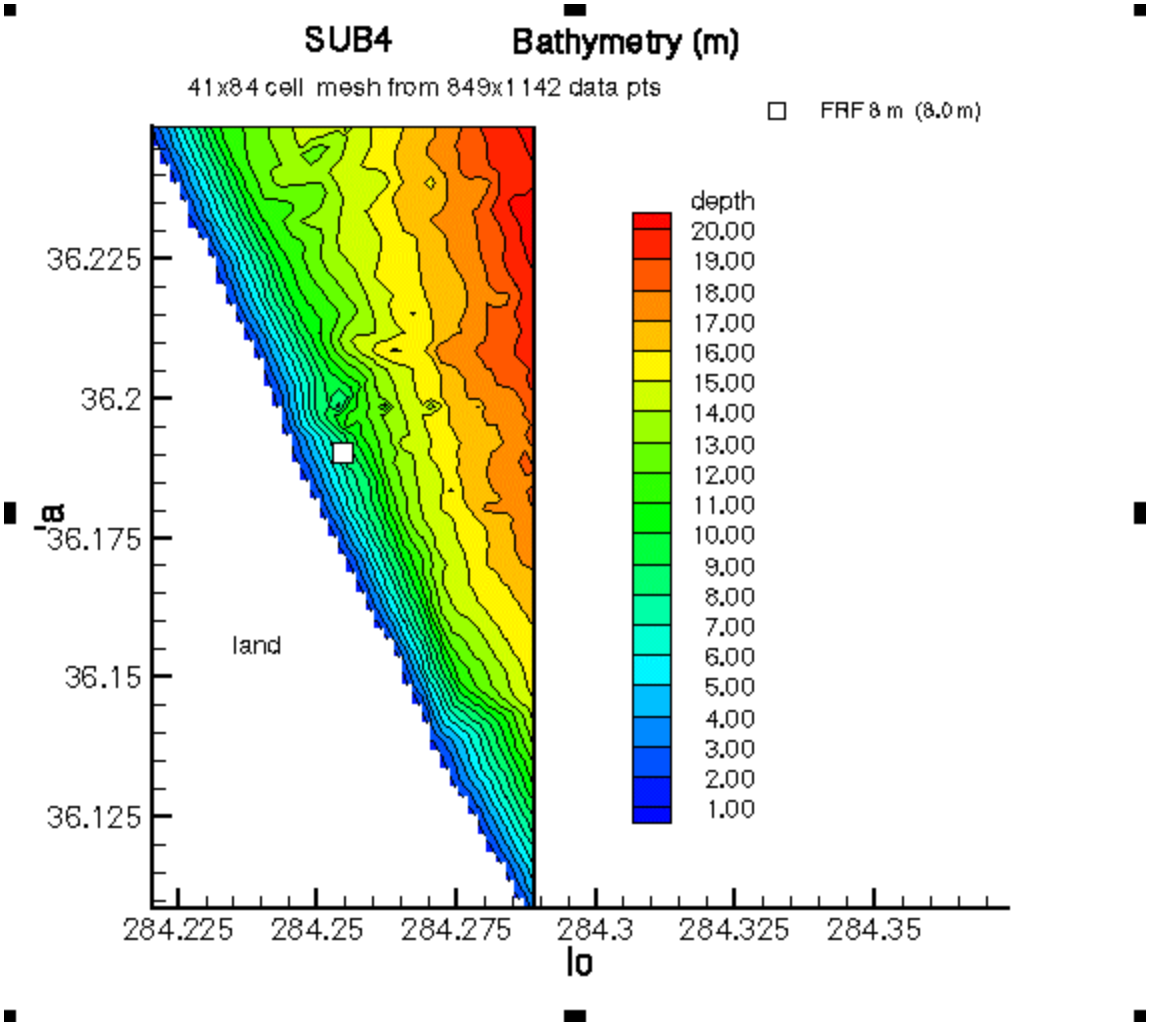
Basin: Wind Field 09/10/95



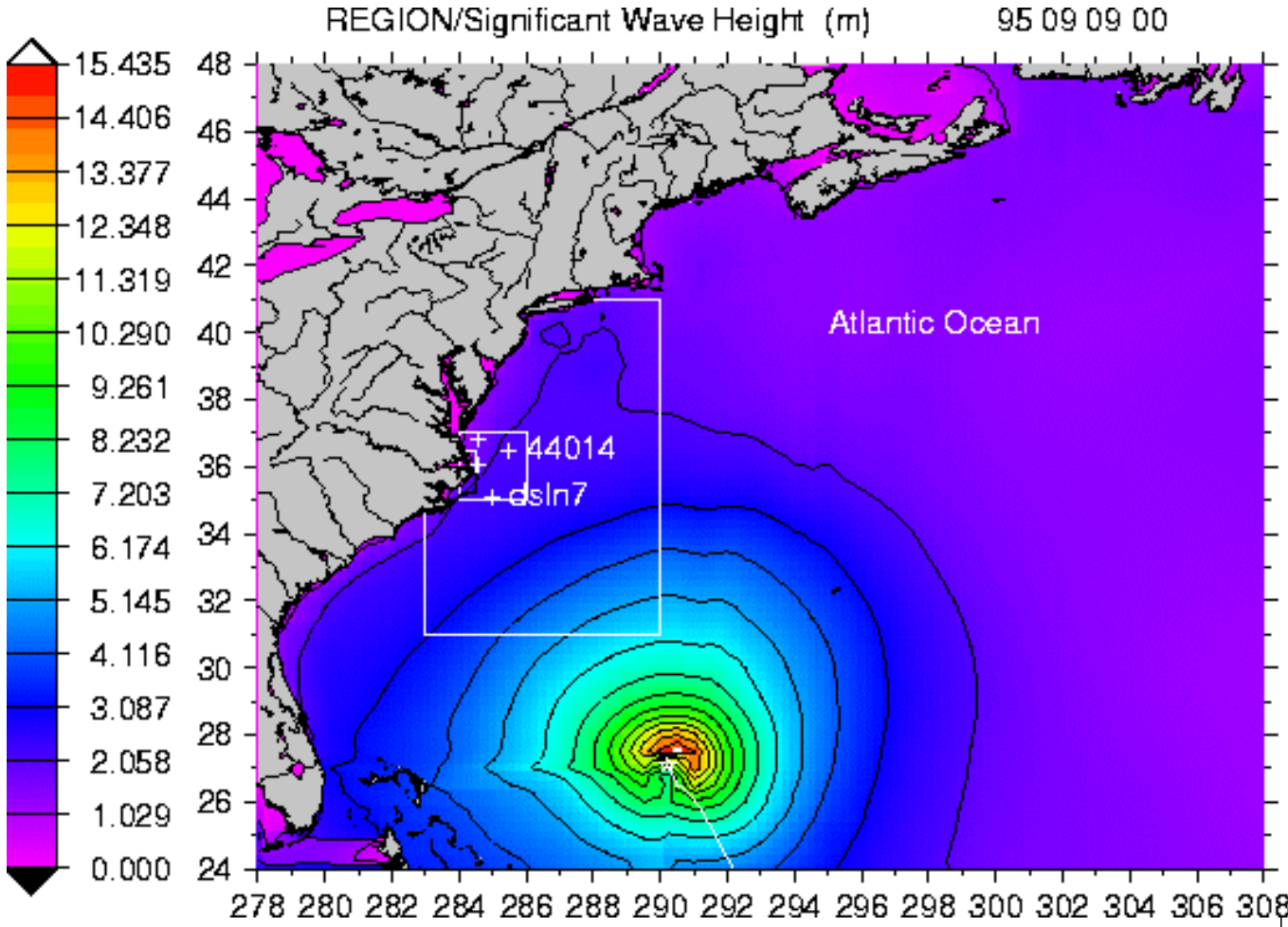
Region: WAM Significant Wave Height 95/09/08



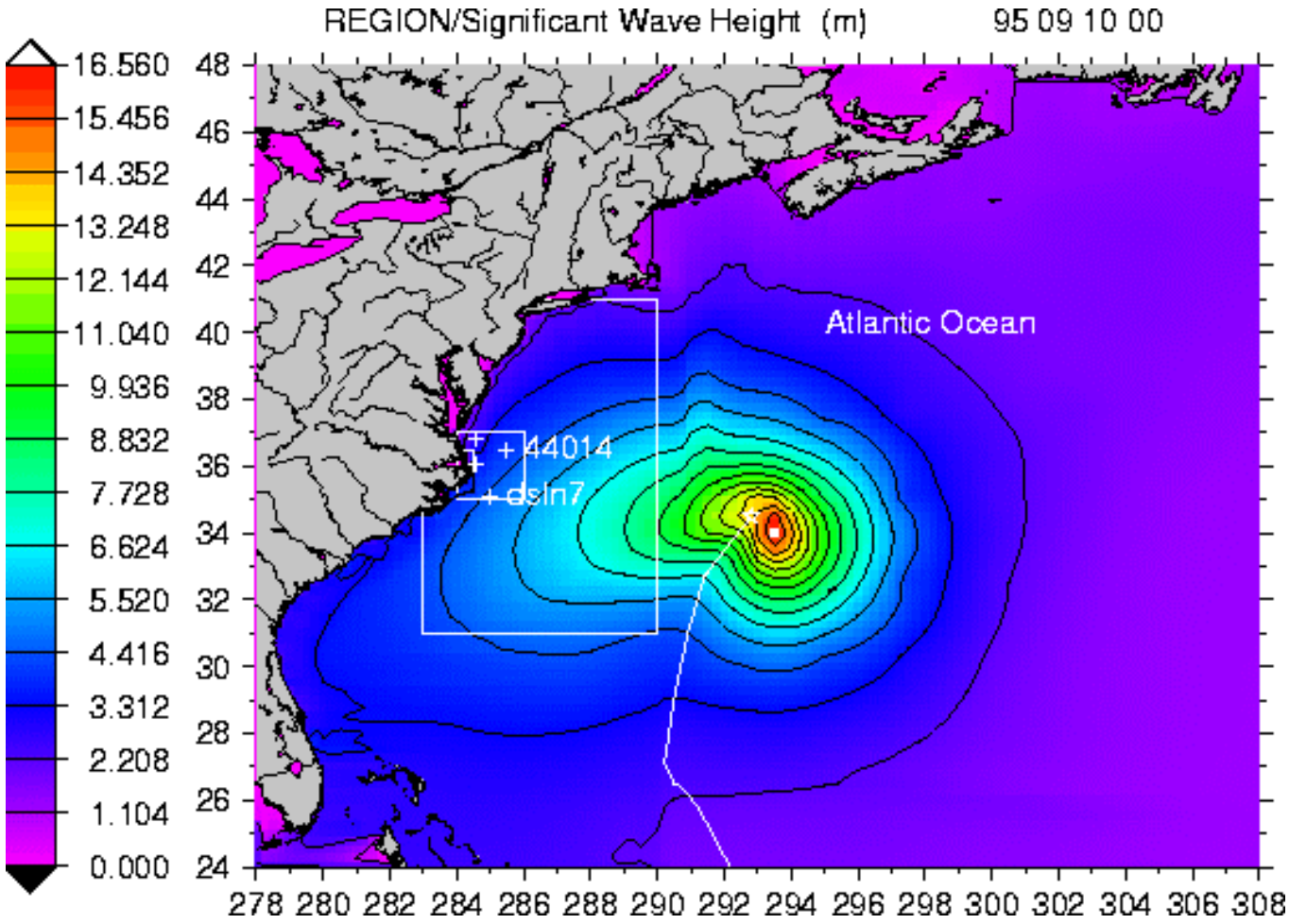
SUB4: bathymetry field



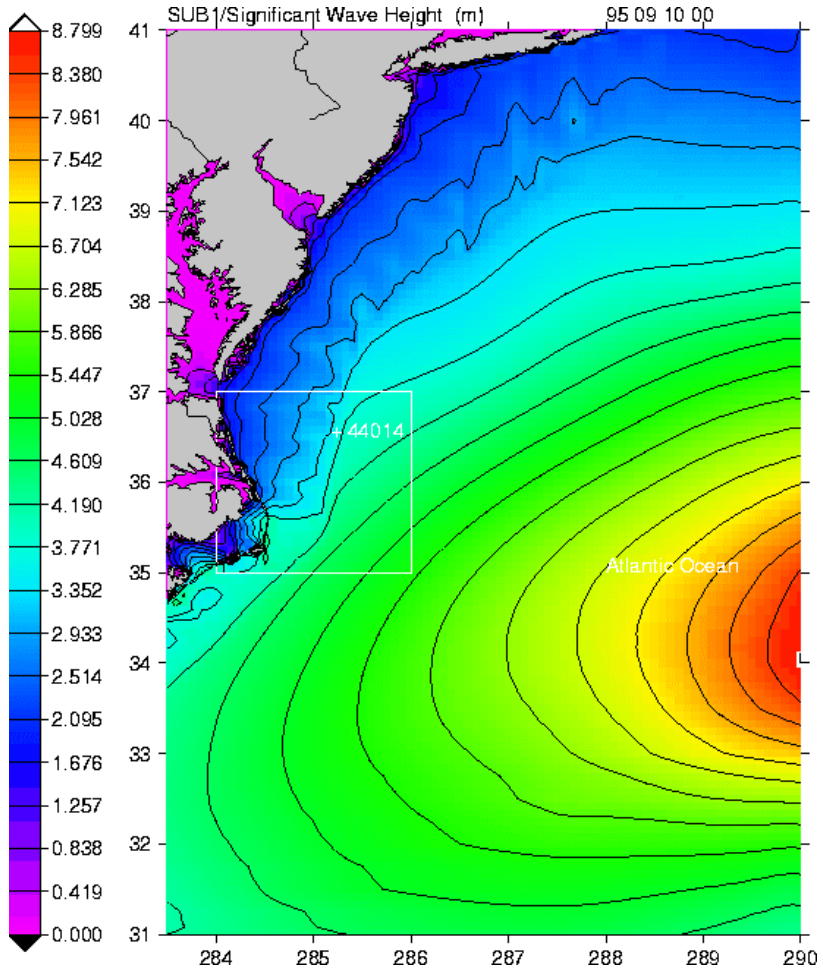
Region: WAM Significant Wave Height 95/09/09



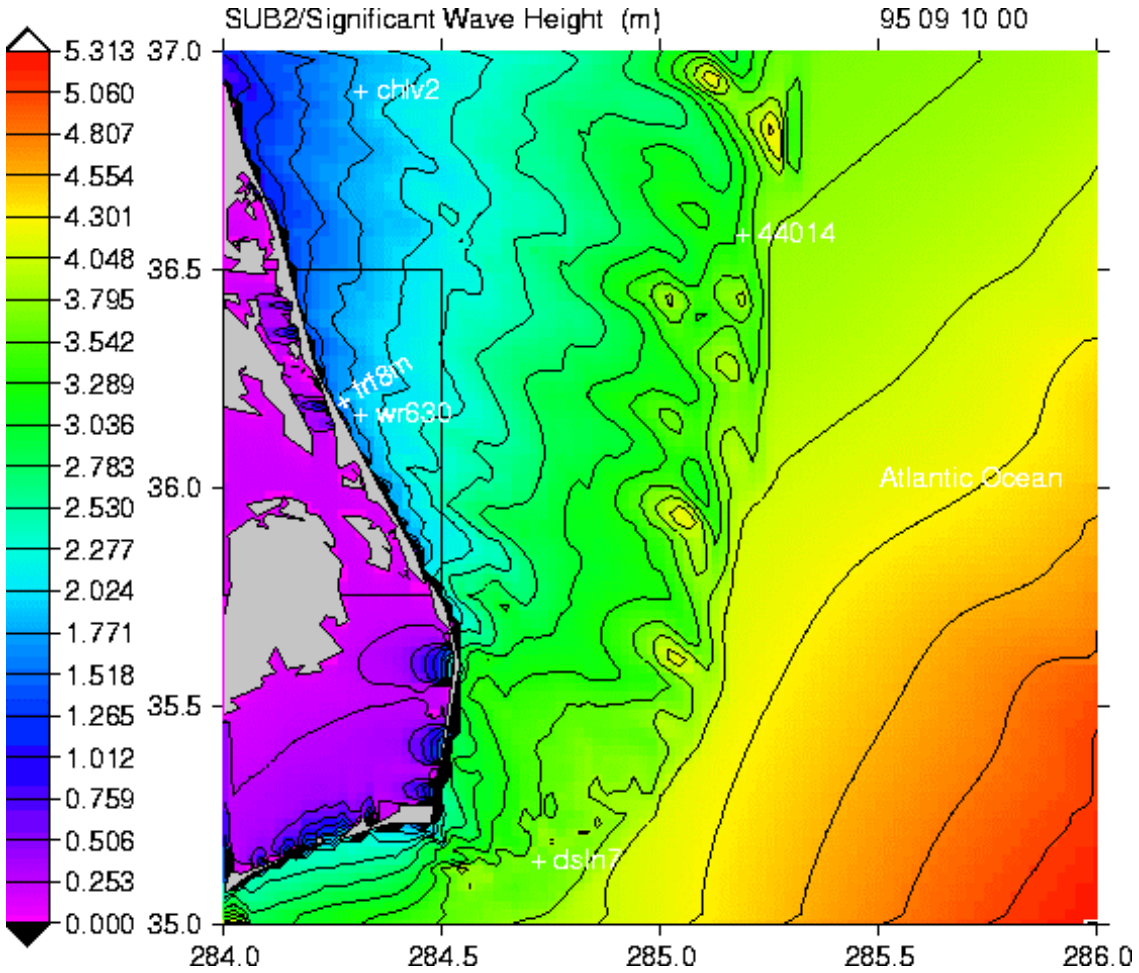
Region: WAM Significant Wave Height 95/09/10



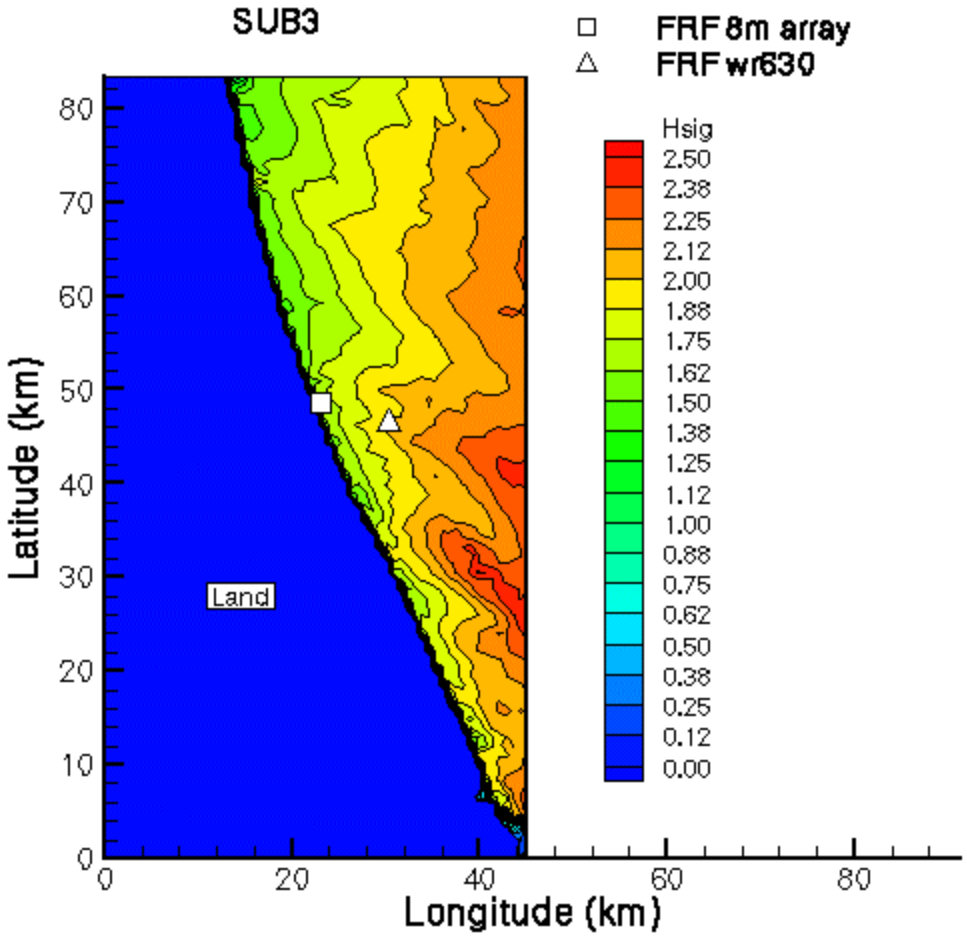
SUB1: WAM Significant Wave Height 95/09/10



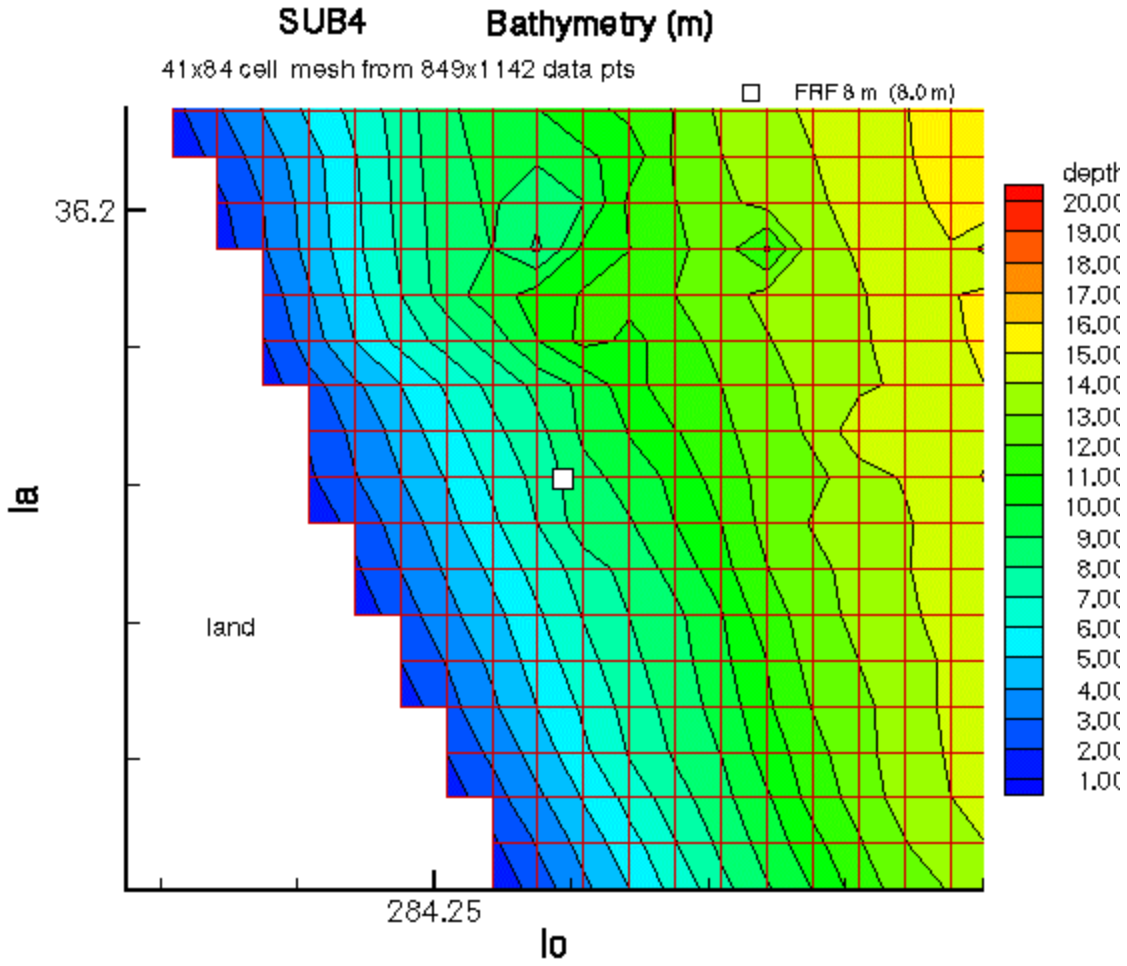
SUB2: SWAN Significant Wave Height 95/09/10



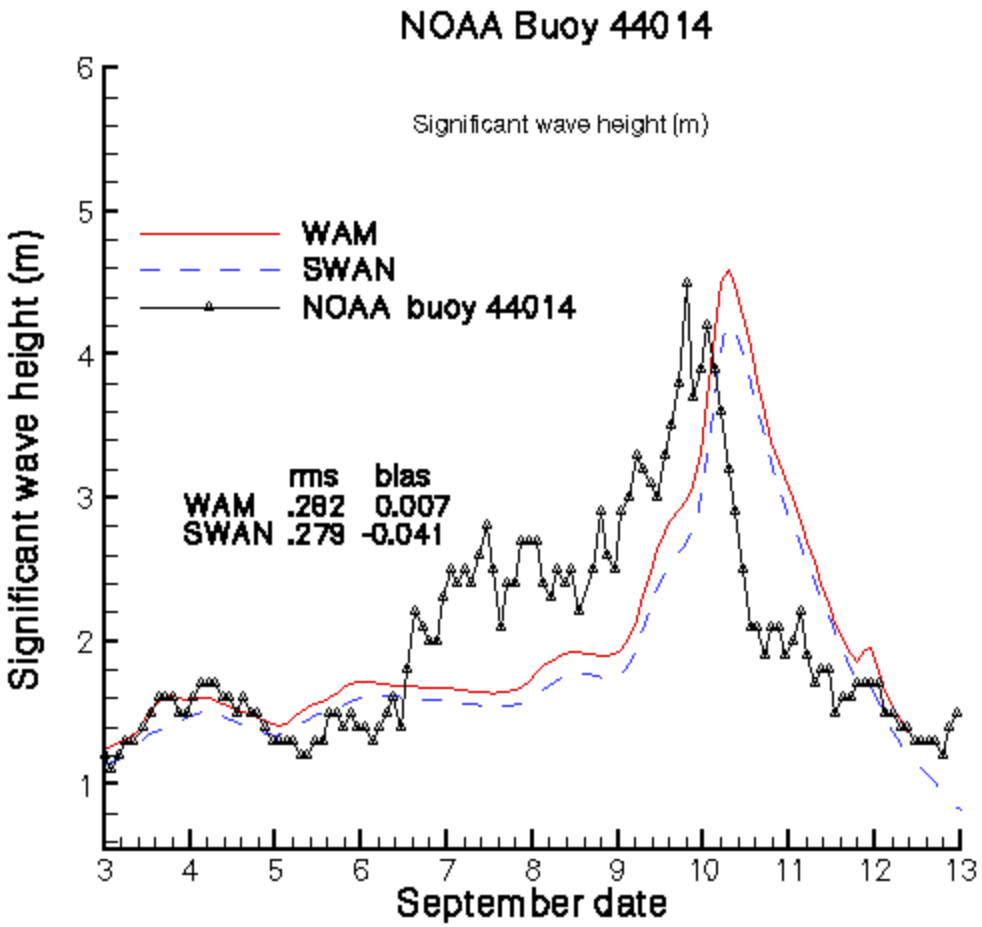
SUB3: Significant Wave Height 95/09/10



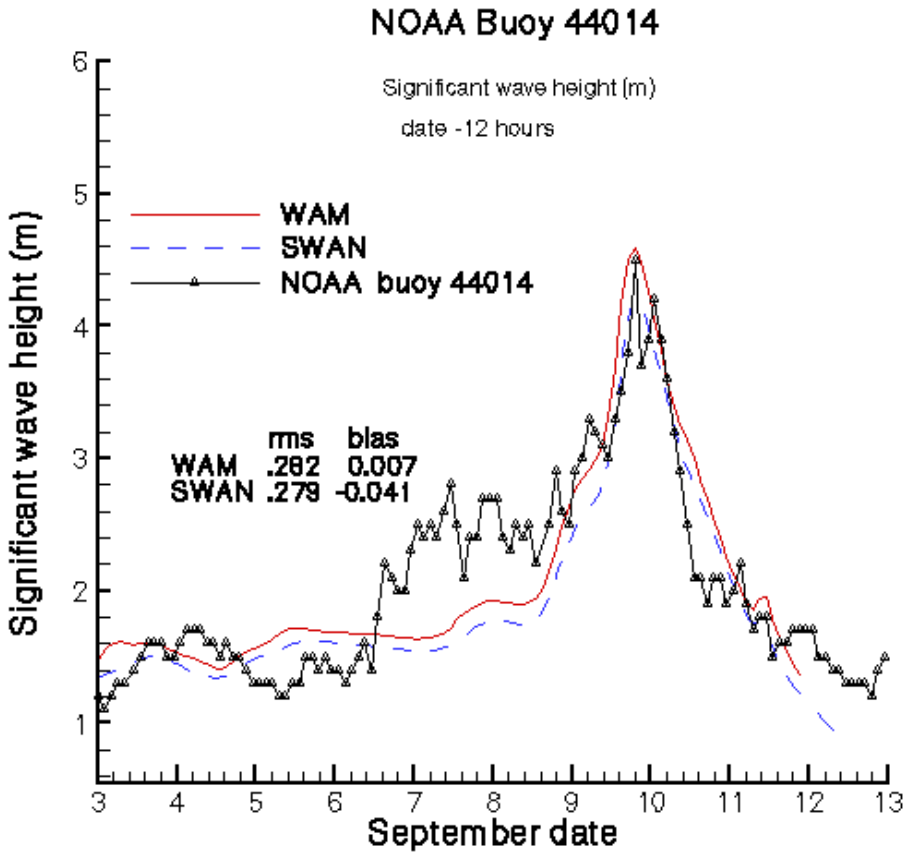
SUB4: zoom


SUB4 Bathymetry (m)
41x84 cell mesh from 849x1142 data pts
FRF 8 m (8.0 m)
depth
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
36.2
land
la
284.25
lo

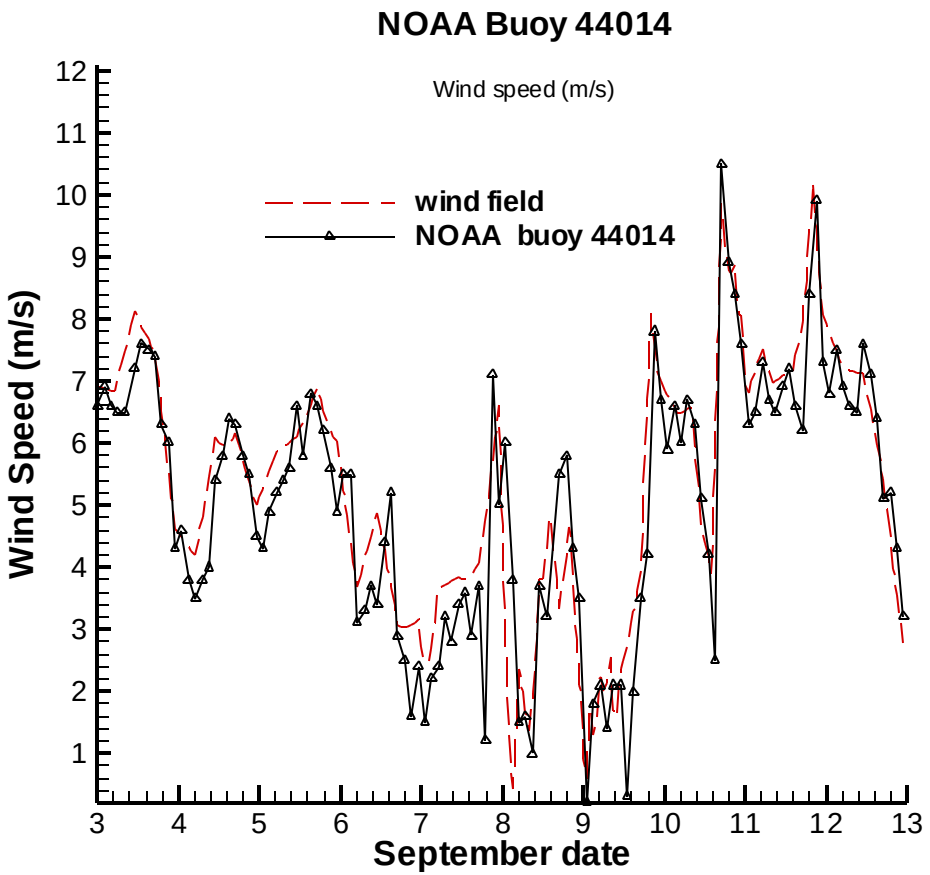
NOAA buoy 44014 significant wave height



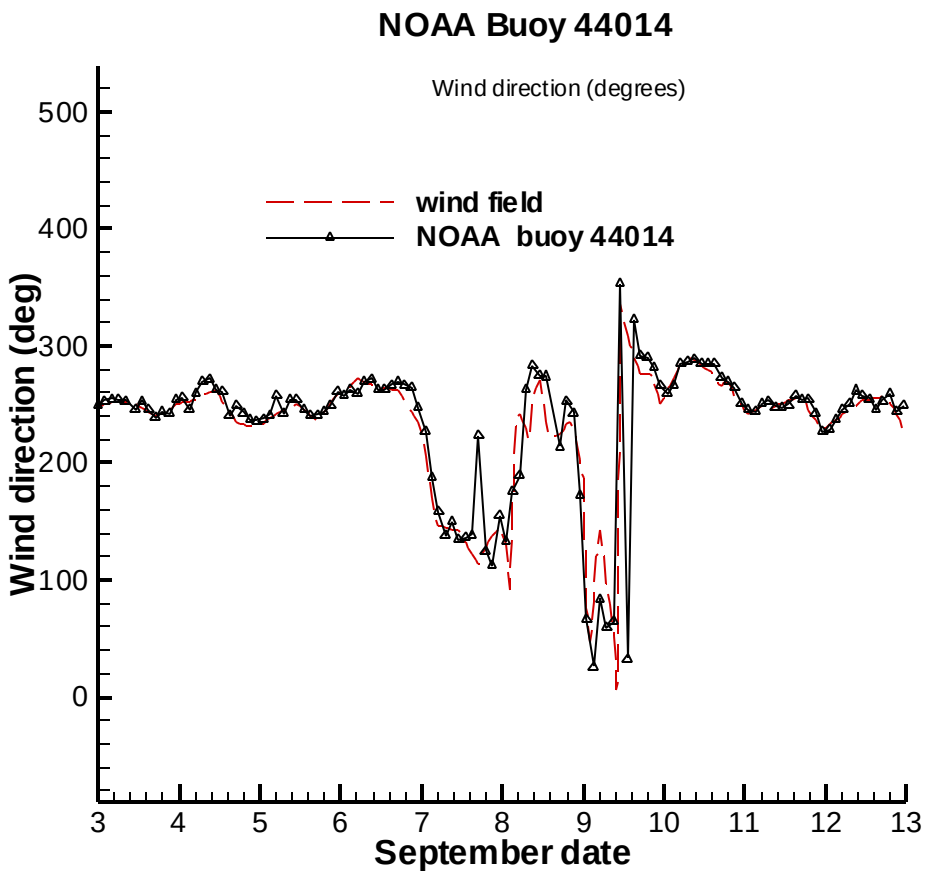
NOAA buoy 44014 significant wave height shifted 12 hours



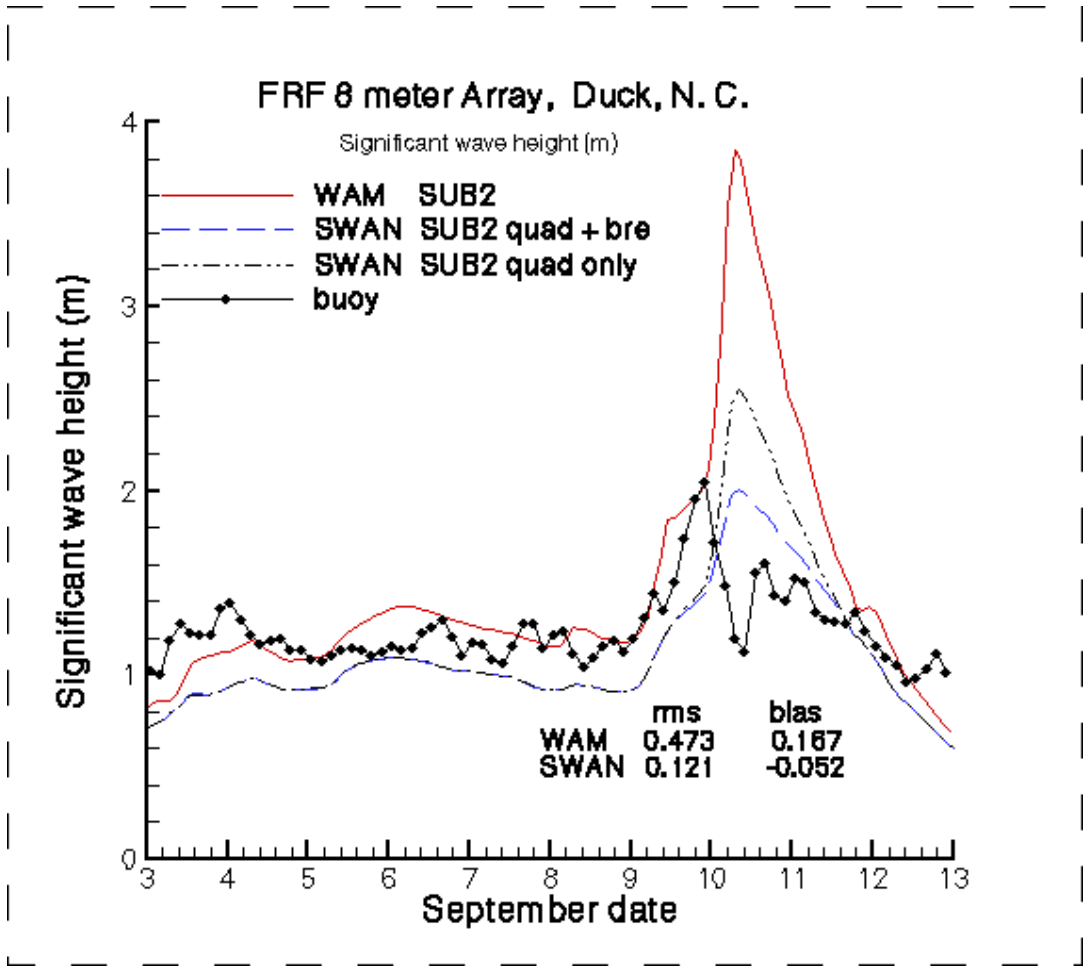
NOAA buoy 44014 wind speed



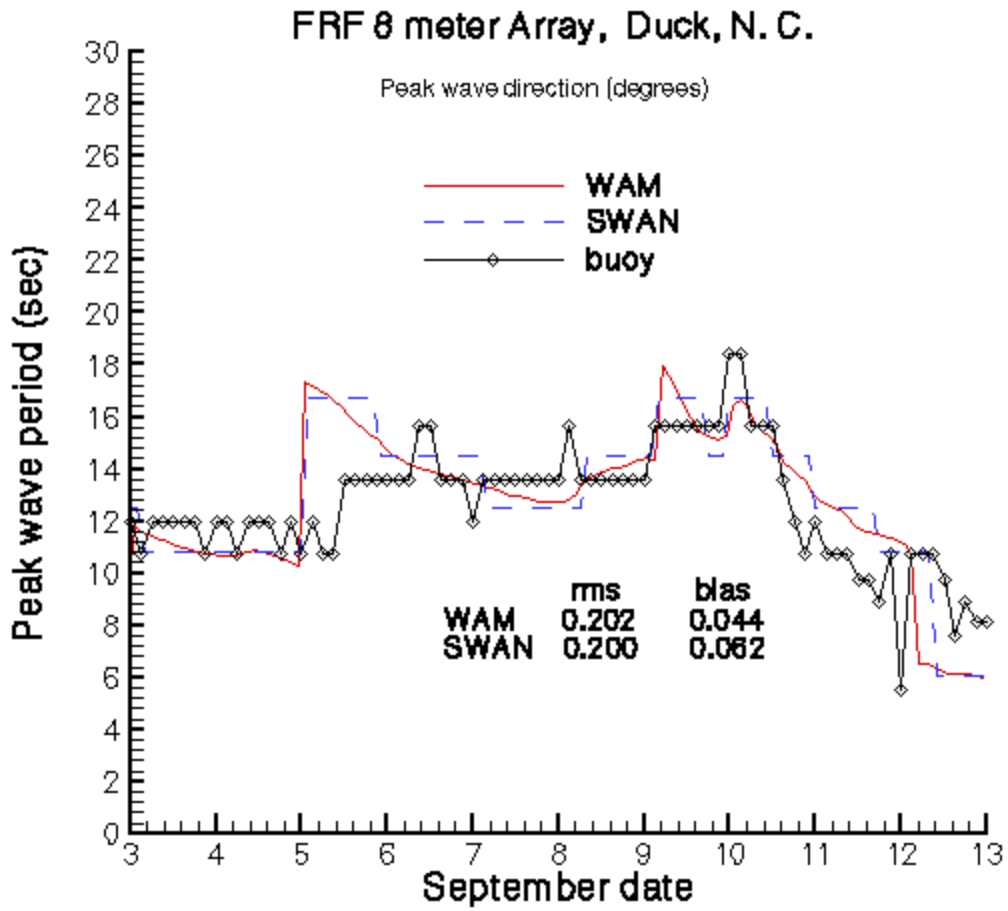
NOAA buoy 44014 wind direction



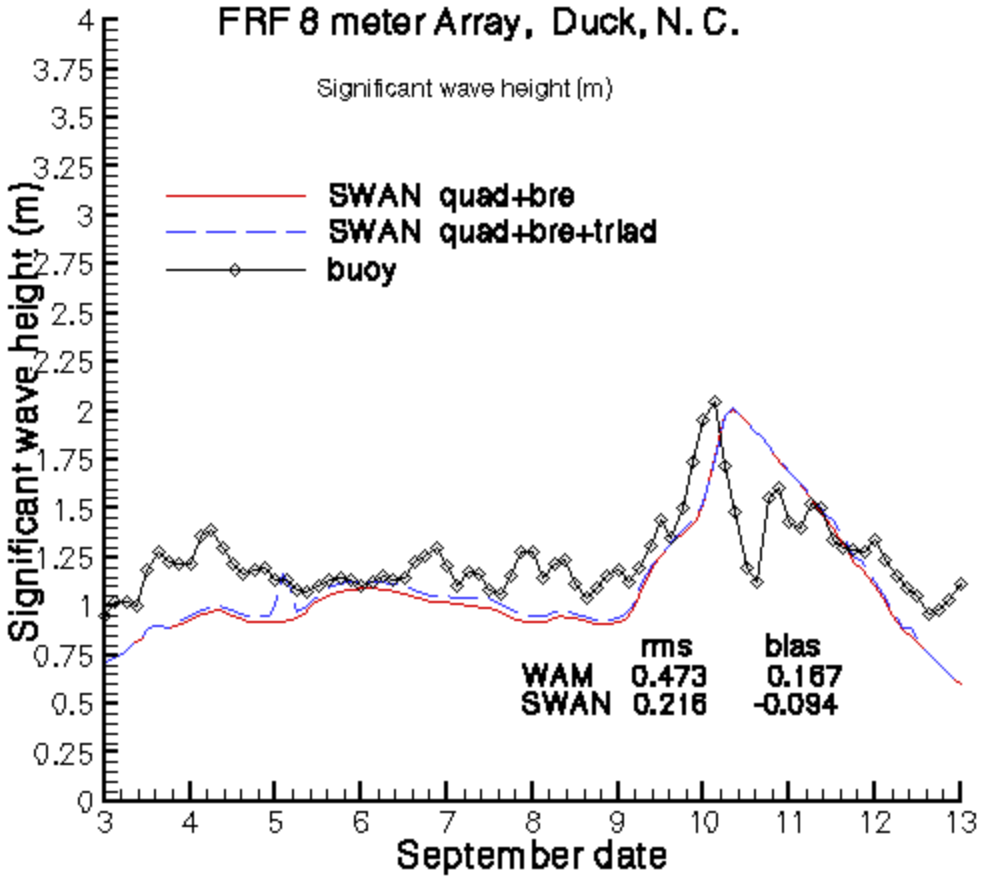
FRF 8 meter array Significant Wave Height



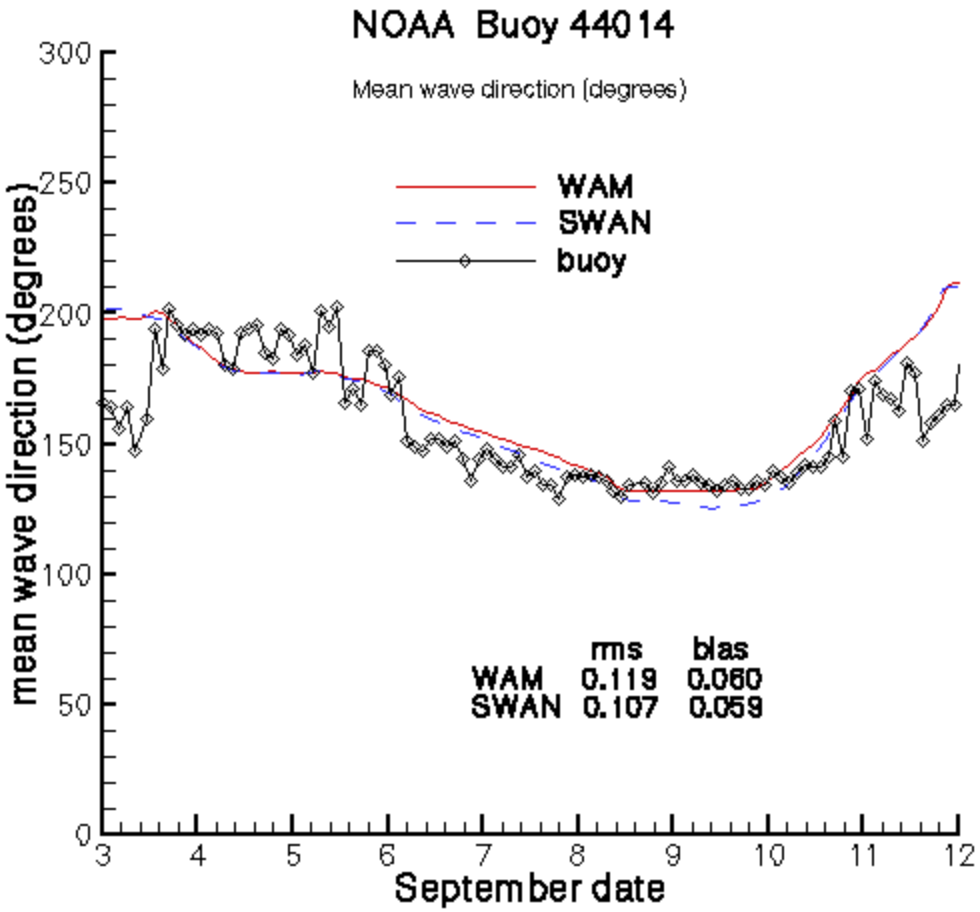
FRF 8 meter array peak wave period



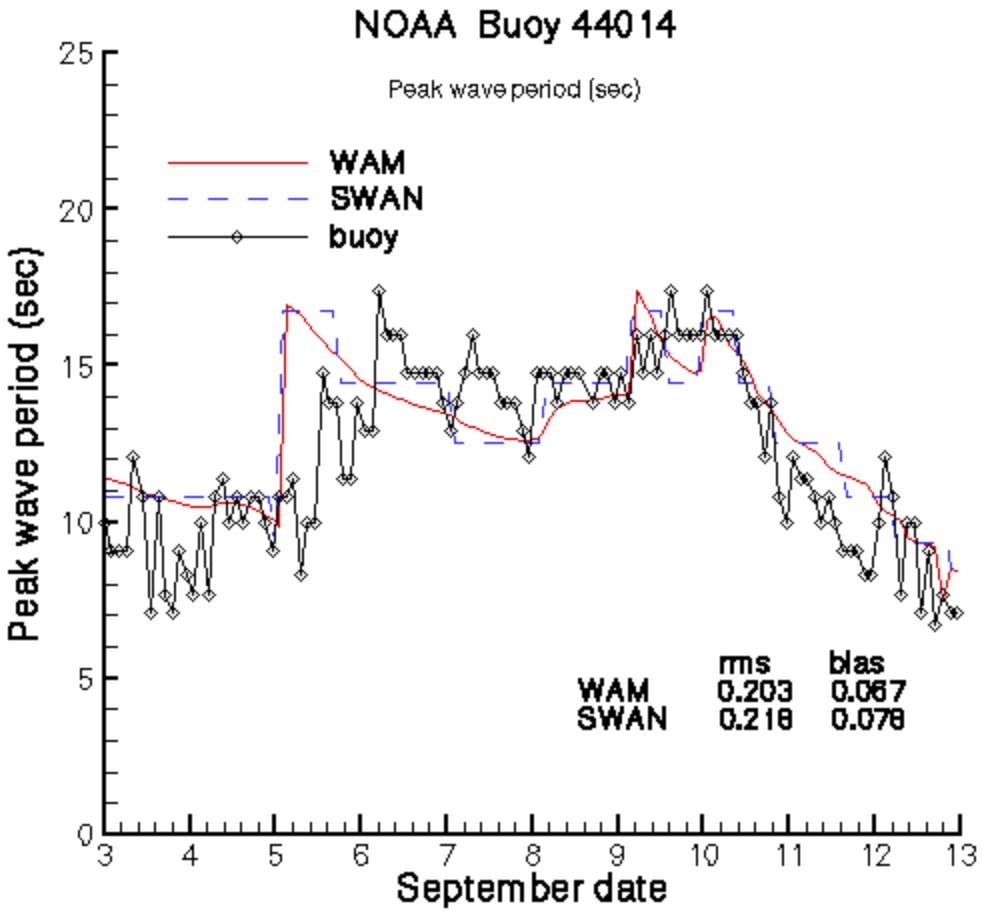
FRF 8 meter array triad wave-wave interaction



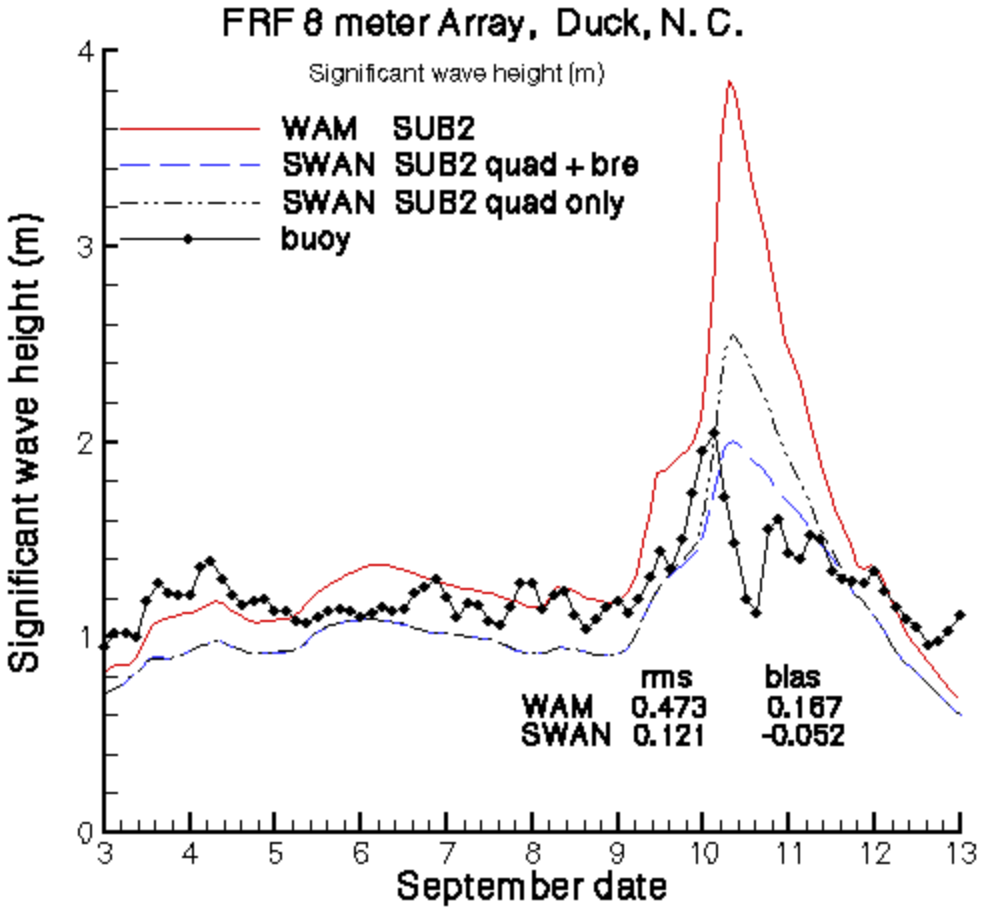
NOAA buoy 44014 mean wave direction



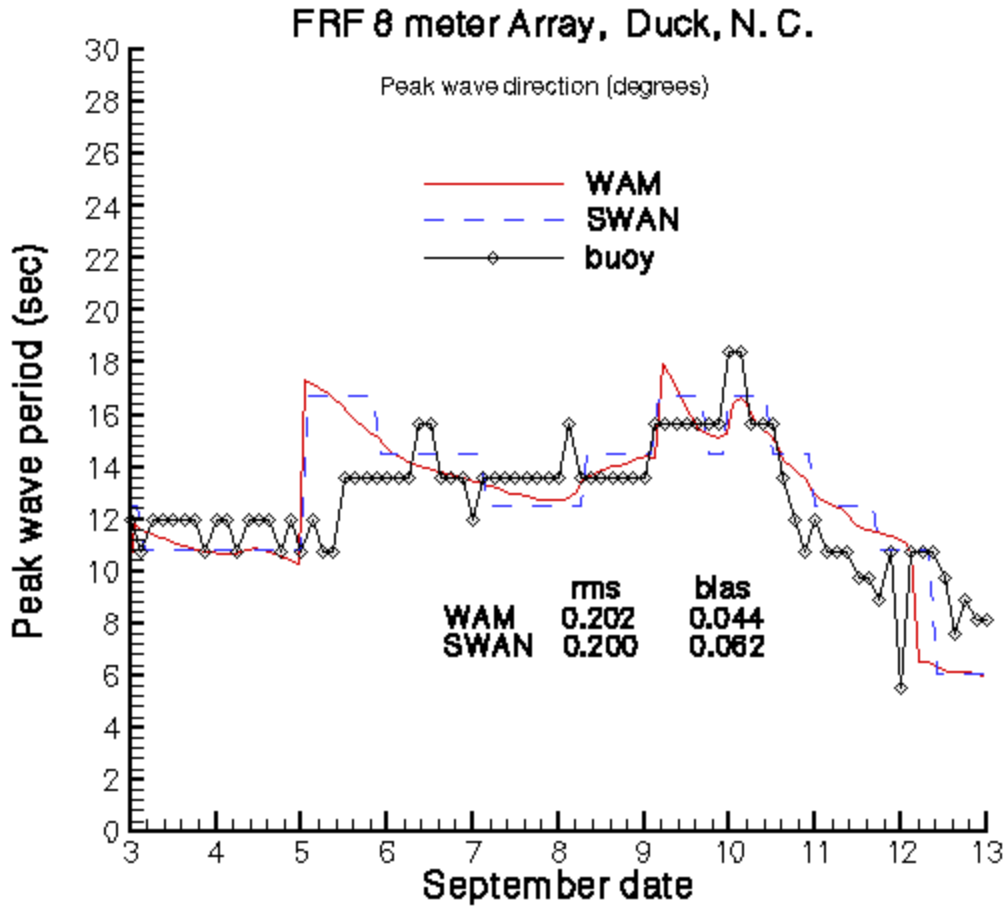
NOAA buoy 44014 peak wave period



FRF 8 m array significant wave height



FRF 8 m array peak wave period



Summary

- SWAN was more accurate when depth-induced wave breaking occurred
  - reason: SWAN depth-induced wave breaking formulation
- SWAN triad wave-wave interaction improved wave estimates
- WAM and SWAN estimates for the peak wave period were approximately the same
- WAM not well suited for fine mesh studies
  - Date stamp limit of 1 minute for time steps
  - Depth must be an integer
  - Boundary files become extremely large
- WAM (production, OpenMP version)
- SWAN (research code, non-parallel, models important nearshore processes)